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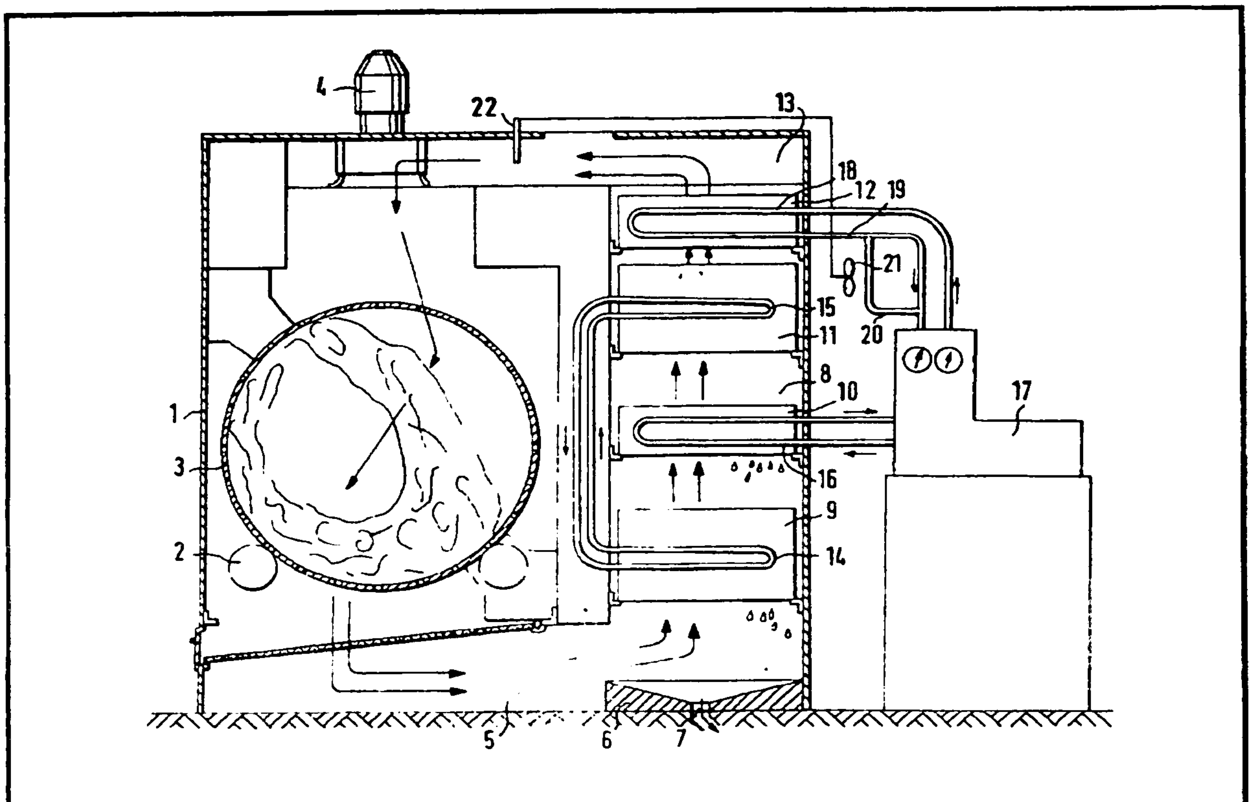
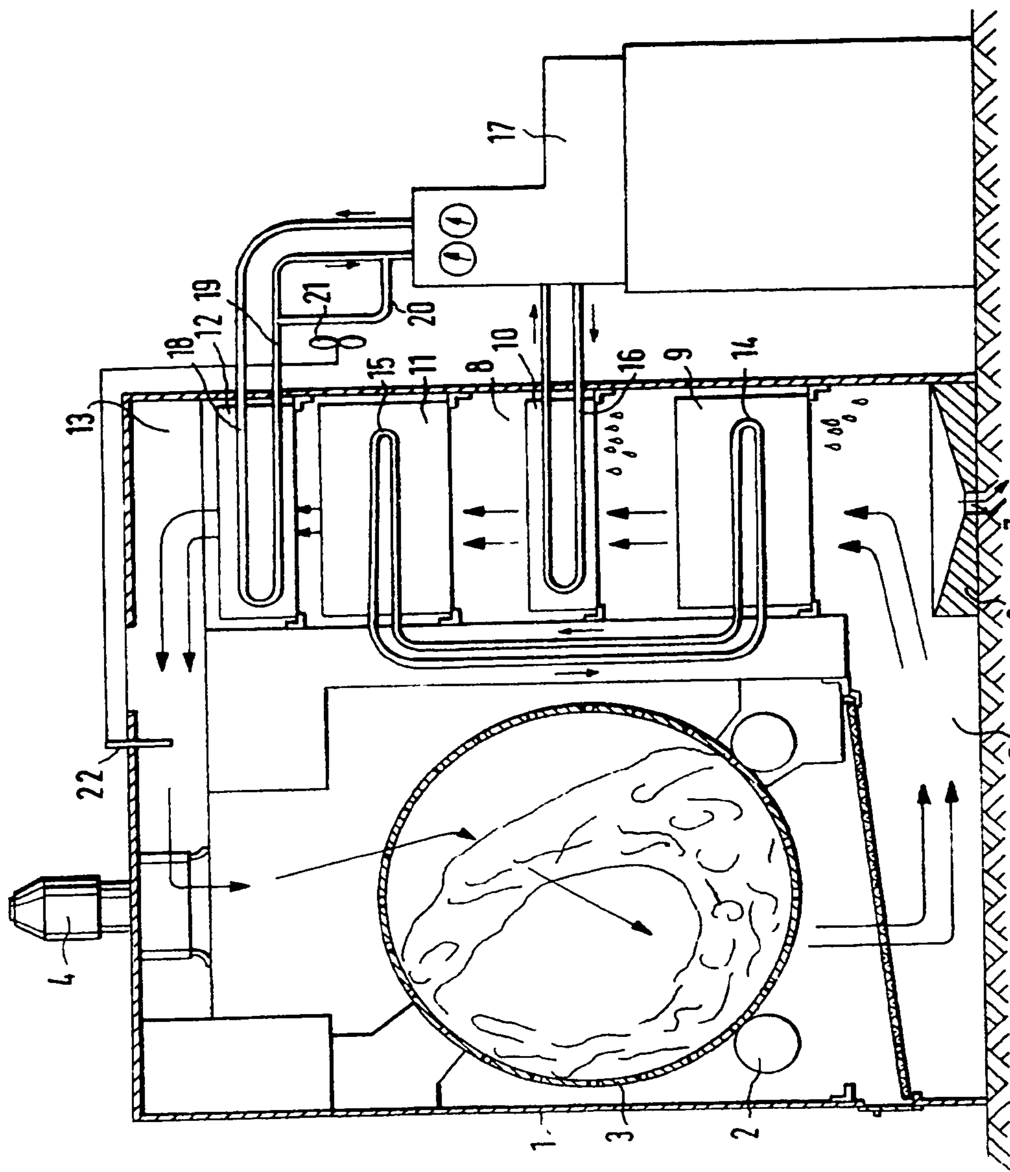
(54) Drying machine

(57) A drying machine has a housing 1, a perforated drum 3 rotatably mounted in the housing, a closed-circuit air path 3, 5, 8 and 13 within the housing, and a blower 4 for blowing air round the closed-circuit air path. The closed-circuit air path passes through the drum 3 between a hot-air inlet and an air-discharge outlet 5. A condenser 10 and a heater 12 are arranged in series in the closed-circuit air path between the air-discharge outlet 5 and the hot-air inlet. The condenser 10 and the heater 12 form part of a heat exchanger, so that heat extracted from the moist air leaving the drum 3 can be used to heat up and dry the air returning to the drum via the inlet.

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SPECIFICATION

Drying machine

This invention relates to a machine for drying articles such as clothes.

A known type of drying machine has a housing, a perforated drum rotatably mounted in the housing, and means for heating and blowing air through the drum. The hot air necessary for drying is produced by means of a heater, for example a steam-generator, and the moist air leaving the drum is discharged into the atmosphere. Such a machine often operates at relatively high temperatures, and in some cases at temperatures above 100°C.

One of the disadvantages of this type of machine is that it is expensive to run, this high expense resulting from the loss of thermal energy caused by discharging the hot moist air into the atmosphere. Another disadvantage is that, in many cases, it is not advisable to dry some materials at such high temperatures. This is particularly the case when drying leather. Leather is best dried using air at room temperature, as this causes the least damage to the material. However, air at room temperature usually has a relatively high moisture content, and this leads to uneconomically lengthy drying times.

The aim of the present invention is to provide a drying machine which permits economical drying at a relatively low temperature.

The present invention provides a drying machine having a housing, a perforated drum rotatably mounted in the housing, a closed-circuit air path within the housing, and means for blowing air round the closed-circuit air path, the closed-circuit air path passing through the drum between a hot-air inlet and an air-discharge outlet, wherein a condenser and a heater are arranged in series in the closed-circuit air path between the air-discharge outlet and the hot-air inlet.

Advantageously, the condenser and the heater are operably connected together by pipes containing a heat-conveying fluid; the condenser, the heater and the pipes constituting a heat exchanger. Preferably, the heat exchanger includes a refrigerator, the condenser being connected to the cold side of the refrigerator by a first pipe, and the heater being connected to the hot side of the refrigerator by a second pipe. Conveniently, that part of the second pipe which contains fluid passing from the heater to the refrigerator is provided with a bypass pipe, a second heat exchanger being provided in the bypass pipe. In this case, the second heat exchanger may be thermostatically controlled in dependence upon the temperature of the air in the region of the hot-air inlet.

In a preferred embodiment, the machine may further comprise a second condenser and a second heater, the second condenser being upstream of the first-mentioned condenser, and the second heater being upstream of the first-mentioned heater. Advantageously, the second condenser and the second heater are operably connected by an endless pipe containing a heat-conveying fluid; the second condenser, the second heater and the endless pipe constituting a third heat exchanger. Preferably, the third heat exchanger is provided with a thermostatically-controlled pump for circulating the heat-conveying fluid in the endless pipe.

A drying machine constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawing, the single figure of which is a schematic, part-sectional, side elevation of the drying machine.

Referring to the drawing, the drying machine has a housing 1 which rotatably supports a perforated drum 3 by means of drive rollers 2. A blower 4 is mounted in the top plate of the housing 1, the blower being arranged to force air through the drum 3 and into an air-discharge duct 5. A condensate dish 6 is located at the downstream end of the discharge duct 5, the condensate dish being provided with a discharge port 7, through which the condensate collected in the dish is discharged.

A drying tower 8 is provided above the condensate dish 6. The drying tower 8 contains a first heater 12, a second heater 11 positioned below the first heater, a first condenser 10 positioned below the second heater, and a second condenser 9 positioned below the first condenser. An air duct 13 leads from the top of the first heater 12 towards the blower 4. Thus, the drying machine defines a closed-circuit air flow path leading from the blower 4, into the drum 3, into the air discharge duct 5, into the drying tower 8, and back to the blower via the duct 13. The second condenser 9 and the second heater 11 are connected together by pipe systems 14 and 15 to form a heat exchanger, the pipe systems 14 and 15 forming a closed-circuit heat-conveying device. Similarly, the second condenser 10 and the second heater 12 are connected together to form another heat exchanger. Here, however, the pipe system 16 of the first condenser 10 is connected to the cold side of a refrigerator 17, and the pipe system 18 of the first heater 12 is connected to the hot side of the refrigerator. A bypass 20 is provided in the return pipe 19 of the pipe system 18, the bypass 20 being provided with a further heat exchanger 21, which is controlled by a thermostat 22 positioned in the air duct 13.

It is also possible to provide a thermostatically-controlled pump (not shown) in the closed-circuit heat-conveying device constituted by the pipe systems 14 and 15.

The drying machine described above oper-

ates in the following manner. The dry air, which is drawn in by the blower 4 and has a temperature of about 45°C, enters the drum 3 with a relatively low humidity of about 13%. In the drum 3, the air becomes saturated, picking up moisture from the tumbling material being dried. When it leaves the drum 3, the temperature of the air is reduced to about 27°C. The saturated air then passes, via the discharge duct 5, to the second condenser 9, where it is cooled to a temperature of about 15°C. The air then passes to the first condenser 10, where it is cooled to about 7 or 8°C. [illegible] this happens, the temperature of the air is below the dew point, and moisture condenses and drips down into the condensate dish 6.

The air then passes to the second heater [illegible], where it is re-heated to attain a temperature of about 15°C. In the first heater 12, the air is further heated to reach a temperature of about 45°C. The dried, hot air then passes along the duct 13 ready for the next cycle.

Since the air passes round the machine in a closed-circuit, the energy required for cooling the air to remove moisture can be put to optimum use, and only minimal losses occur due to radiation of heat, even when (for the purpose of maintaining the temperature of the hot air) additional heat escapes into the atmosphere from the heat exchanger 21. Thus, the drying machine described above uses only [illegible]% of the energy required to operate know drying machines having the same capacity.

Apart from the economies achieved by the drying machine described above, it dries sensitive material, and in particular leather, much better than known machines. Using known machines, for example, sheepskin shrinks by up to 20%. With the machine described above, however, only about 10% shrinkage occurs. Moreover, the skin remains stretchable, so that it can be readily restored to full size, whereas shrinkage occurring during drying using known machines can only be made good to a very slight extent.

It has been found that, with the drying machine described above, leather can be successfully dried at temperatures less than 50°C, and that textiles can be dried at temperatures less than 65°C. Moreover, a temperature greater than 60°C can be used for dehydrating leather, if this figure is reduced to below 50°C for the final drying stage.

Another advantage of the drying machine described above is that it improves the quality of the dried materials, not only for leather, but also for textiles, particularly towelling and woollen goods. This improvement is attributable to the fact that residual moisture can be retained in the "dried" material in a precise manner. Thus, in the case of woollen goods, matting of the fibres can be largely avoided.

CLAIMS

1. A drying machine having a housing, a perforated drum rotatably mounted in the housing, a closed-circuit air path within the housing, and means for blowing air round the closed-circuit air path, the closed-circuit air path passing through the drum between a hot-air inlet and an air-discharge outlet, wherein a condenser and a heater are arranged in series in the closed-circuit air path between the air-discharge outlet and the hot-air inlet.

2. A drying machine as claimed in claim 1, wherein the condenser and the heater are operably connected together by pipes containing a heat-conveying fluid; the condenser, the heater and the pipes constituting a heat exchanger.

3. A drying machine as claimed in claim 2, wherein the heat exchanger includes a refrigerator, the condenser being connected to the cold side of the refrigerator by a first pipe, and the heater being connected to the hot side of the refrigerator by a second pipe.

4. A drying machine as claimed in claim 3, wherein that part of the second pipe which contains fluid passing from the heater to the refrigerator is provided with a bypass pipe, a second heat exchanger being provided in the bypass pipe.

5. A drying machine as claimed in claim 4, wherein the second heat exchanger is thermostatically-controlled in dependence upon the temperature of the air in the region of the hot-air inlet.

6. A drying machine as claimed in any one of claims 1 to 5, further comprising a second condenser and a second heater, the second condenser being upstream of the first-mentioned condenser, and the second heater being upstream of the first-mentioned heater.

7. A drying machine as claimed in claim 4, wherein the second condenser and the second heater are operably connected by an endless pipe containing a heat-conveying fluid; the second condenser, the second heater and the endless pipe constituting a third heat exchanger.

8. A drying machine as claimed in claim 5, wherein the third heat exchanger is provided with a thermostatically-controlled pump for circulating the heat-conveying fluid in the endless pipe.

9. A drying machine substantially as hereinbefore described with reference to, and as illustrated by the accompanying drawing.

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